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SAMPLING PROTOCOLS FOR THE RAPID BIOASSESSMENT OF STREAMS AND LAKES USING BENTHIC MACROINVERTEBRATES

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SAMPLING PROTOCOLS

FOR THE RAPID BIOASSESSMENT

OF STREAMS AND LAKES

USING BENTHIC MACROINVERTEBRATES

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EXECUTIVE SUMMARY

Rapid bioassessment protocols have been developed as inexpensive screening tools to identify sites in streams and lakes that may have impaired water quality. This report summarizes rapid bioassessment methods currently used by the Aquatic Science Section of the Ontario Ministry of Environment and Energy. These protocols are undergoing extensive testing to ensure their general utility, accuracy and repeatability. In the future these simple methods may be used with the assistance of the general public to establish whether the macroinvertebrate fauna of a given lake or stream is characteristic of healthy unimpacted waters, or indicative of degraded conditions.

Historically, benthic macroinvertebrate collections were often sorted in their entirety and then identified to the species or genus taxonomic level. This approach provides detailed biological data that generally reflect water quality; however, these types of exhaustive censuses are time consuming and expensive. In recent years rapid bioassessment techniques have been introduced as cost-effective screening tools. Rapid bioassessments are often based on a subsample of 100 animals that are identified to the taxonomic level of order rather than species or genus. This reduction in taxonomic detail and increased degree of subsampling greatly reduces the costs and the amount of expertise required for biological assessments. Furthermore, these aspects of rapid bioassessments provide an opportunity to utilize inexperienced volunteers to undertake biological assessments. As a result, ongoing studies will establish if rapid bioassessment protocols can be used by inexperienced volunteers to identify potentially impacted areas where follow-up studies may be warranted. In order to confirm the degree of impairment, these follow-ups may require traditional biological surveys and water-quality testing. Consequently, the following rapid bioassessment methods are only intended as simple, cost-effective screening tools that distinguish healthy sites from those sites where further investigation may be necessary.

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INTRODUCTION

Macroinvertebrates are relatively sedentary, exhibit varying tolerances to physical and chemical changes and they are widespread in their distribution. As a result, macroinvertebrate collections have been used extensively as a means to assess degraded water quality in streams and lakes (Wilhm and Dorris 1968, Barton and Metcalfe-Smith 1992, Metcalfe-Smith 1994). Although field samples are relatively easy to collect, it is generally time consuming and labour intensive to identify all of the animals to the species or genus taxonomic level. Consequently, the laboratory processing of a large number of samples can be quite expensive.

The recent development of rapid bioassessment techniques (e.g., as utilized by the United States Environmental Protection Agency; Klemm et al. 1989, Plafkin et al. 1990) capitalizes on the experience gained from complete macroinvertebrate enumerations, but permits the sampling of a large number of streams or lakes at a much lower cost (e.g., Hilsenhoff 1988, Resh and Jackson 1993, Chessman 1995, Resh et al. 1995). This saving is achieved by extensive subsampling and only identifying these animals to the coarse taxonomic level of order (or higher).

The protocols that follow are experimental rapid bioassessment protocols that were developed to complement standard methods employed by staff at the Dorset Environmental Science Centre of the Ontario Ministry of Environment and Energy (e.g., Reid et al. 1995). The methodology is a blend of protocols used by other jurisdictions

(e.g., Plafkin et al. 1990, Shaw et al. 1992, Resh et al. 1995, Stanfield et al. 1996). The goal of these rapid bioassessment protocols is to provide an inexpensive, relatively accurate screening tool that can be used by people with little or no expertise in aquatic ecology (e.g., Firehook and West 1995, Penrose and Call 1995). Currently, these protocols are being ground-truthed to determine whether the resultant data have sufficient accuracy and precision to detect known differences in the water quality of streams and lakes. Further changes may be implemented following this trial period.

METHODS

Stream and Site Selection - Streams are chosen according to the specific requirements of the assessment, although a series of "control" or reference streams should also be sampled in order to characterize normal or background conditions. Within a given stream, only riffles are sampled because of the high productivity and high diversity of organisms associated with this type of habitat (as compared to pools). If no riffles are found, then debris dams and snags provide a reasonable substitute. Water depths should be less than one metre. Three riffles are selected as representative sites, with variable distances between them depending on stream morphology. Once these sites are chosen the sampling begins at the site furthest downstream so that the remaining sites are undisturbed until sampled.

However before sampling, local Conservation Authorities and the Ministry of Natural Resources should be contacted. Each agency is usually interested in biological assessments within their jurisdictions. In addition, staff from these agencies can help determine if the proposed stream sites are on private property. If so, arrangements should be made with the landowner to ensure safe access to the sites.

Lake and Site Selection - Lakes are also chosen according to the requirements of the assessment, but again a number of unimpacted or "control" lakes should also be sampled to adequately characterize background or normal conditions relative to a particular stress. Within each lake 5 representative sites should be sampled. These 5 sites should be randomly selected from a series of candidate sites in proportion to the different types of nearshore habitats. For example, if aquatic plant or macrophyte beds were found in 60% of the nearshore areas, then 3 out of the 5 sites should have macrophytes. In some cases, especially with small lakes, it may be difficult to find sites that are dissimilar with respect to the type of lake bottom. In this instance all 5 sites may comprise a single substrate type such as silt or sandy areas. Other types of common substrates include bedrock, boulders, cobbles, gravel and organic debris or detritus. It is important to choose sites that are as representative or characteristic of the lake as possible.

Much like the stream protocol, local Conservation Authorities and the Ministry of Natural Resources should be contacted before undertaking the rapid bioassessment. Staff

from these agencies can assist in determining the best access points and whether potential sampling sites are on private property. If so, arrangements should be made with the landowner to ensure safe access to the sites.

Equipment List

- road and/or topographic maps
- pencils and/or china markers
- tape (for labelling the outside of the vials)
- waterproof paper (labels to be placed inside the vials if possible)
- meter stick
- thermometer (alcohol type, not mercury in case of breakage)
- a seine net (60 x 110 cm 500 μm mesh (window screen) attached to two 2 cm wooden dowlings with staples, making a 60 cm high x 100 cm wide net). Top and bottom edges of the screen should be reinforced with duct tape before attaching it to the dowling.
- fine-tipped forceps
- small pieces of screen (e.g., 2 cm x 8 cm) for "scooping" invertebrates that move on the surface of the water
- guide to distinguishing characteristics of aquatic invertebrates (Appendix 1)
- 3 benthic enumeration sheets per stream (1 for each riffle) **OR** 5 benthic enumeration sheets per lake (i.e., 5 sites; see Appendix 2)
- 3 plastic buckets (1 for the sample, 1 for water and 1 for the subsample to be picked)
- squeeze bottle for water
- container of 95% ethanol (may be difficult to obtain); **OR** 70% isopropanol or "rubbing" alcohol
- white plastic vials for preserving organisms (or similar small bottle that can be sealed without leaking)

Sampling Procedures - Numerous rapid bioassessment techniques are currently in use (e.g., Resh and Jackson 1993, Resh et al. 1995). Among the various methods, there is some discrepancy as to the number of invertebrates needed in each sample (as well as the number of sites) to provide a reasonably accurate and precise

description of the water quality in a stream or lake. Based on current rapid bioassessment strategies (e.g., Plafkin et al.1990), we use a subsampling technique that requires only 100 animals. We have found that it takes about 45 minutes for 2 people to pick 100 animals from a sample. Confirmatory statistical analyses are underway to establish whether this minimum number of animals is sufficient to accurately distinguish streams or lakes of differing water quality (e.g., Hannaford and Resh 1995). The general sampling procedures are outlined below.

Streams - Benthic invertebrates are collected with a kick-and-sweep method using a poled seine net. Sampling is conducted over a one-minute period in an area of approximately 1 m^2. This area may vary somewhat depending on the shape of the stream where the riffle is located. In some cases the stream may be too narrow, so the length of the area sampled would be longer than 1 meter, to compensate for the decrease in width. The seine net is placed against the bottom of the stream downstream from the sampler who stirs up the substrate by kicking the stream bottom. Extra time may be required to scrape the bottom of rocks if cobbles or rocks are found within the riffle. The net will also need to be lifted periodically to prevent clogging and to place invertebrates and debris into a bucket.

Lakes - Benthic invertebrates are collected from each of 5 representative sites in a given lake using a kick-and-sweep method and a poled seine net. Sampling is conducted over a ten-minute period, being standardized to a constant period of time

rather than a standard unit of area (e.g., Okland and Okland 1979, Reid et al. 1995). During this time period a number of transects are sampled. Each transect is perpendicular to shore running offshore to a depth of approximately 1 meter. The actual length of the transect varies depending on the slope of the lake bottom. One sampler faces the shore and walks with the seine net towards shore while following the first sampler who kicks up the substrate in front of the net. Periodically, the net may have to be emptied into a bucket which can be carried by the sampler who is kicking up the substrate. If the transect is short, additional transects must be completed during the ten-minute time period. The number of transects sampled and the approximate length of each transect should be recorded on the back of the benthic enumeration sheets. Much like the stream protocol, when rocks and/or logs are present in the shallows they should be scraped off into the bucket to collect any attached invertebrates.

Recording Site Location and Description Information - After the sample is collected, a physical description of the site should be recorded on the back of the benthic enumeration sheet (e.g., stream width, depth, length and riffle location). Site locations should be marked directly on maps or a small sketch should be made (e.g., see Appendix 3). For lakes, the number of transects and the length of the transects sampled at each site should also be recorded, as well as the specific location of each site with respect to established landmarks (i.e., roads, bridges, cottages, etc.; see Appendix 4). At this time, air and water temperatures should also be recorded.

Once the water column has cleared, a brief description of the sediments at the site

should be recorded. This step is extremely important because the type of sediment (or substrate) can influence the type of macroinvertebrates that are found. Substrate types are listed at the top of the benthic enumeration sheets (see Appendix 2). The different types can be checked off if present. Where several types are found at a site, approximate percentages of each substrate should be recorded. The presence and percent cover of aquatic plants (submerged or emergent) should also be noted. In addition, the presence of an oil sheen, rust-coloured sediments, or other unusual aspects or the site should be recorded on the enumeration sheet.

Picking the Samples - Large conspicuous animals may be picked off the screen and placed directly into the vial once they are identified and enumerated. The remaining sample in the seine net is washed into a plastic bucket with the aid of the squeeze bottle. Because some macroinvertebrates will stick to the screen, it is important that any remaining organisms or debris are carefully brushed off the screen into the bucket.

At most, 20 of the larger more-obvious animals are picked from the complete sample, identified to order and enumerated on the bench sheet. To reduce sampling bias, attempts must be made to also remove the smaller animals. If the sample is large, several small subsamples are randomly selected to ensure that representative organisms are enumerated. Each randomly selected subsample of the sediment, debris and associated invertebrates (approximately 1 tbsp.) is placed into a clean bucket containing approximately 2-3 cm of water. Any organisms that swim along the surface of the water (e.g., amphipods) should be scooped from the water using a small

piece of screen. Those animals mixed among the sediments and debris are then removed using tweezers or a piece of screen. Each animal is identified to order, placed in the sample vial and enumerated on the bench sheet. The vial should be labelled and it should contain 95% ethanol alcohol (or 70% isopropanol) to adequately preserve the specimens.

Special effort should be made to look for organisms such as snails or small clams that sink to the bottom of the bucket and may be missed. Once approximately 100 animals have been enumerated, the remainder of the sample is returned to the stream or lake. In some cases, fewer than 100 animals may be found in a sample (this applies mainly to stream collections). This usually occurs if the substrate at the site is unsuitable for most invertebrates; i.e., insufficient food supply, or unsuitable habitat such as bedrock. For this reason, great care must be taken in the initial site selection.

The name of the stream, the riffle number (1, 2 or 3) and the collection date should be recorded on the vial and the enumeration sheet. The same information should be recorded for lakes (i.e., lake name, site number (1-5) and collection date). It is essential that water-proof pencils or china markers are used. Ethanol and water will erase or smear many types of ink or markers.

Identifying the Animals to Taxonomic Order - It is important to become familiar with the key characteristics of the invertebrates before attempting to sort and identify the animals. For each taxonomic group, Appendix 1 provides a size range, colour, typical

movements and an illustration of representative animals. It is important to take all of these aspects into consideration before deciding which group a specimen belongs to. It is helpful to watch the invertebrates swimming in the water as most groups have distinct methods of locomotion. Careful sorting is required because animals attached to the sediment and associated debris are difficult to see. If some animals cannot be identified, simply include them in the vial and make note of this on the enumeration sheet under a miscellaneous category.

SAMPLE SUBMISSION

For each stream, the bioassessment will produce 3 benthic data sheets and associated vials. Five sheets and associated vials will be obtained for each lake. Photocopies of the bench sheets should be made by the investigator and saved for future reference. The original bench sheets and the labelled vials should be sent with a covering letter to the rapid bioassessment coordinator at the Dorset Environmental Science Centre. The covering letter should describe the study area, the reason for the bioassessment and relevant details associated with the field collections (e.g., problems obtaining sufficient animals, identification difficulties, lost samples, etc.). Be sure to include a return address (and a phone or FAX number) in order to receive follow-up information from the rapid bioassessment coordinator.

The coordinator will enter the data into a simple spreadsheet and verify the accuracy of the computerized data. Subsequently, the data will be stored in a formal database with

the information on the site location and associated habitat description.

DATA EVALUATION

The resultant data will be used to calculate a series of biological indices or metrics (e.g., Barbour et al. 1992, Norris and Georges 1993). These metrics will be selected from a variety of indices that are currently used in routine biological assessments of water quality (e.g., Plafkin et al. 1990, Gibbons et al. 1993, Jackson 1993, Reid et al. 1995). The calculated values for each sample will be compared to reference or control sites in order to score the sample on a relative scale ranging from unimpacted to potentially impacted. Using this simple comparative approach, the rapid bioassessment coordinator will calculate a series of metrics and determine the relative "health" of each site. The results of this evaluation will be entered into the computerized database and subsequently sent to the individual who submitted the samples. These analyses will also provide benchmarks to determine whether these protocols provide reasonable accuracy and precision to classify streams and lakes according to their water quality.

Results of preliminary sampling are currently being compiled. Metric selection and statistical analyses are ongoing. A summary report documenting the findings of this ground-truth exercise will be distributed after the analyses are completed. Further information will be available from the rapid bioassessment coordinator.

ACKNOWLEDGEMENTS

This report outlines protocols currently used for the rapid bioassessment of streams and lakes by the Aquatic Sciences Section of the Ontario Ministry of Environment and Energy. These protocols were developed through extensive collaboration with Ron Ingram at the Dorset Environmental Science Centre. In addition, Les Stanfield and Dr. Mike Jones of the Ontario Ministry of Natural Resources provided numerous suggestions to improve and simplify these protocols. Prof. Don Jackson at the University of Toronto and Bruce Kilgour at the University of Waterloo suggested solutions to various problems that we encountered. Numerous staff and students assisted with the field collections and sample sorting. We thank all of these individuals for their contributions. Lastly, we also thank the Ontario Rangers of Moose Lake and their supervisors, who volunteered to collect and enumerate samples during the summer of 1996.

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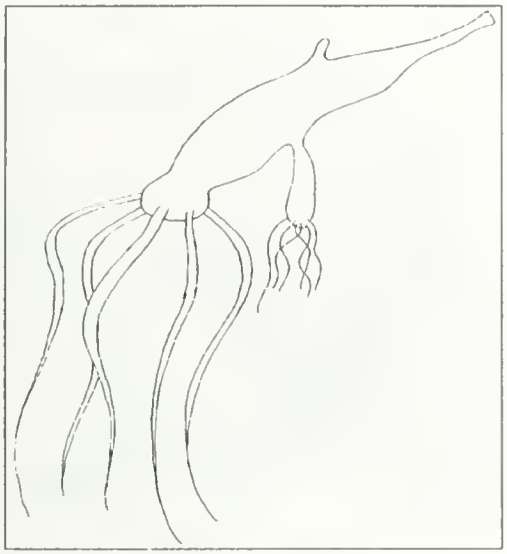
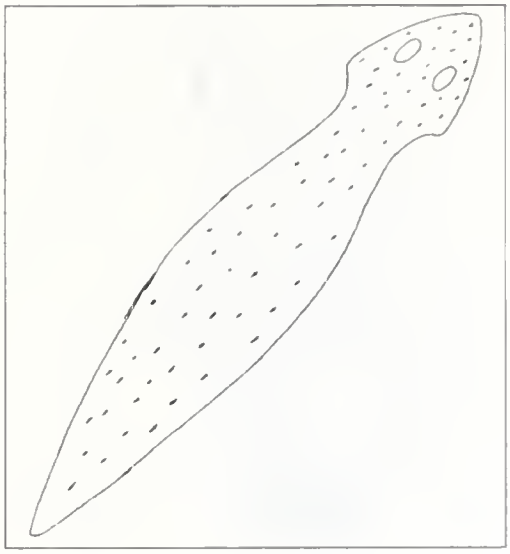
APPENDIX 1

GUIDE TO DISTINGUISHING CHARACTERISTICS OF AQUATIC INVERTEBRATES



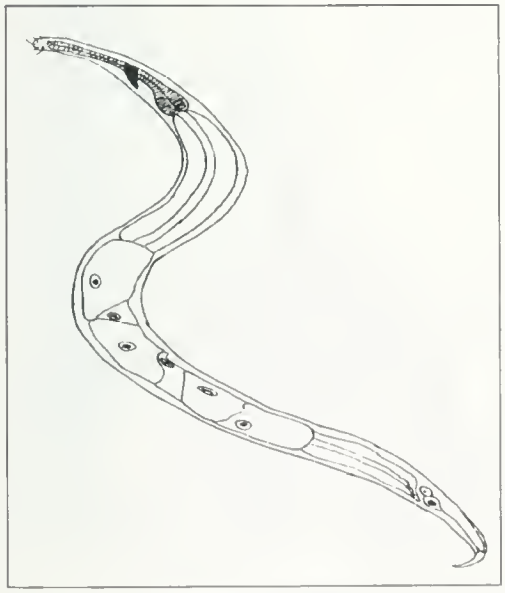
Coelenterata (Hydra)

- inconspicuous, 2-25 mm long
- colour varies but often clear to whitish
- tubular shape with tentacles (little octopus)
- usually attached to an object



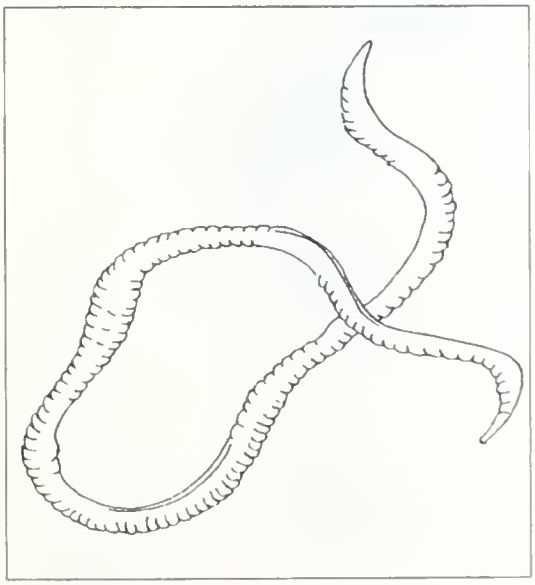
Turbellaria (flatworms)

- 5-30 mm long, greyish-brown or colourless
- very flat 'worms', heads with eyespots
- non-swimmers
- creep slowly on bottom of sorting tray



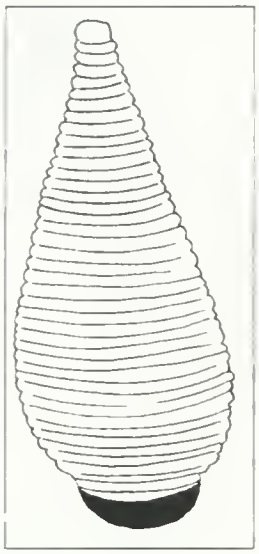
Nemata (transparent worms)

- usually less than 1 cm long, frequently clear
- head usually tapered, tail pointed
- not segmented
- detected by their rapid, whip-like movements



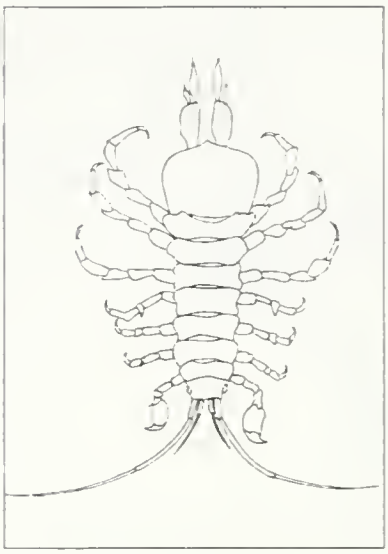
Oligochaeta (aquatic earthworms)

- 1 to 30 mm long, often pinkish
- look like earthworms
- segmented bodies, pointed head and tail
- crawl along bottom of tray



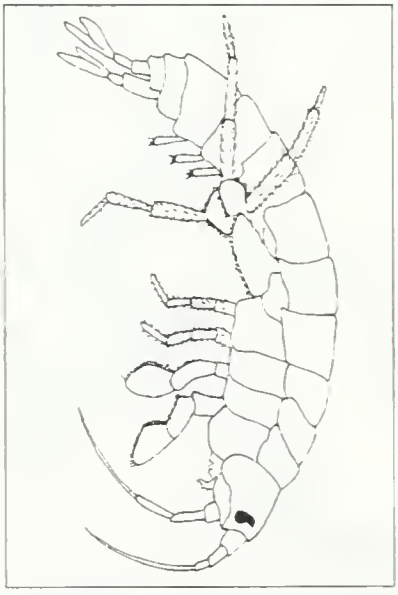
Hirudinea (leeches)

- 5mm-30 cm long
- colour varies often brown or black
- some green on top, orange on bottom
- suckers at both ends, move by inching along



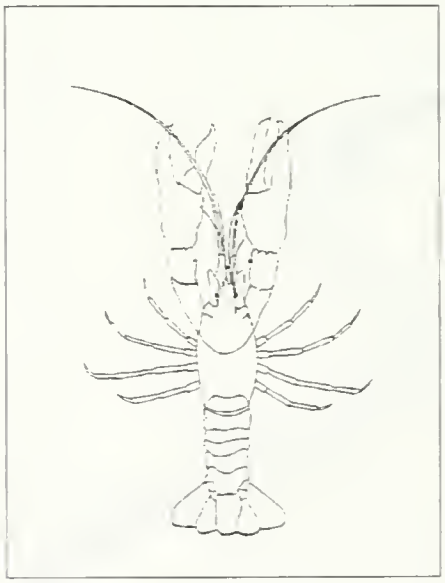
Isopoda (sow bugs)

- 5-20 mm long; brown, black, reddish or yellow
- very flat, segmented crustacean with many legs
- often associated with plants, moss, etc.
- crawl slowly in sorting tray



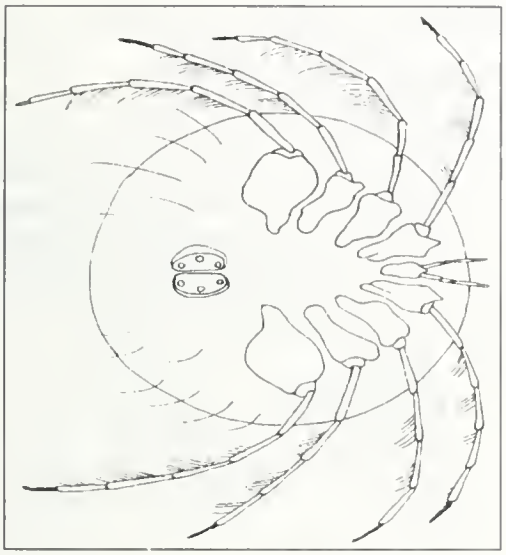
Amphipoda (scuds, sideswimmers)

- 5-20 mm long, bluish grey, brown, green, red
- tiny, curled up shrimp; half circle shape
- long antennae and many legs, fast swimmers
- appear to be lying on their side
- catch with eyedropper



Decapoda (crayfish)

- 1 to 15 cm long, often green, brown, blue
- look like small lobsters
- large claws, hard-shelled, eyes on stalks
- walk without turning on side
- swim quickly backwards to escape

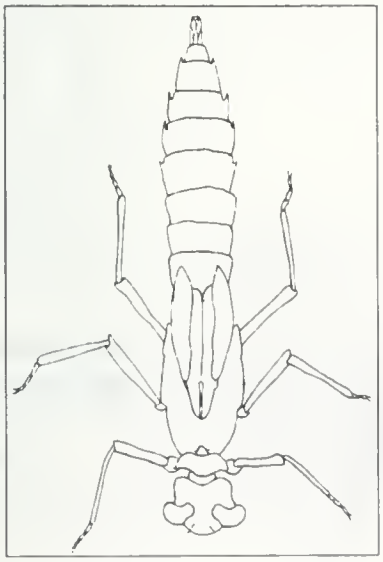


Hydracarina (mites)

- 0.4-3 mm bright red, green, blue or brown
- look like small spiders, eight legs
- bodies soft and round or oval shaped
- uncoordinated, scrambling swimming motion
- *magnified bottom view shown*

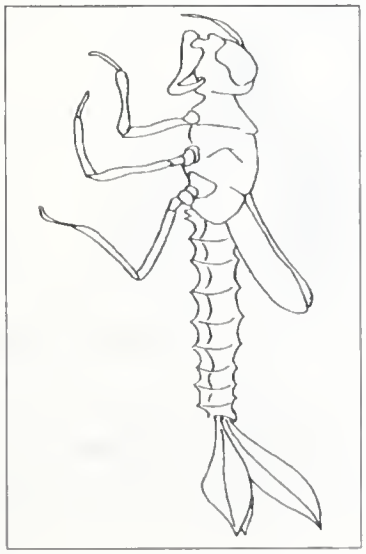
Ephemeroptera (mayflies)

- 3-28 mm long not counting the 3 spined tail
- brown or brownish black, many shapes
- large body and head, 6 legs that stick out at sides
- feather like gills under abdomen
- swim up and down in 's' pattern



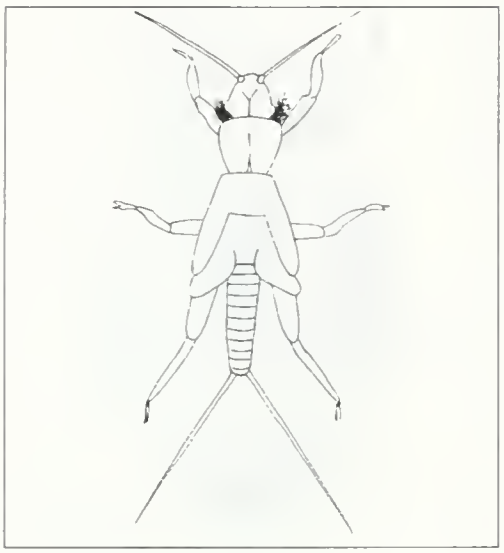
Odonata-Anisoptera (dragonflies)

- 15-45 mm, green to greenish brown
- larger than mayflies with no tail
- large eyes, protruding lip, variable shapes
- often flat, legs stick out sides, slow moving



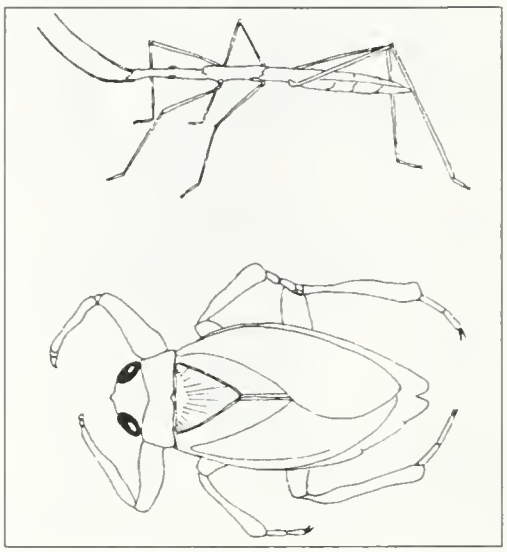
Odonata-Zygoptera (damselflies)

- 10 to 22 mm long, green to greenish brown
- bodies more tubular, thinner than dragonflies
- have a tail with 3 gills unlike dragonflies
- three pairs of legs that stick out at the sides,
- more active than dragonflies



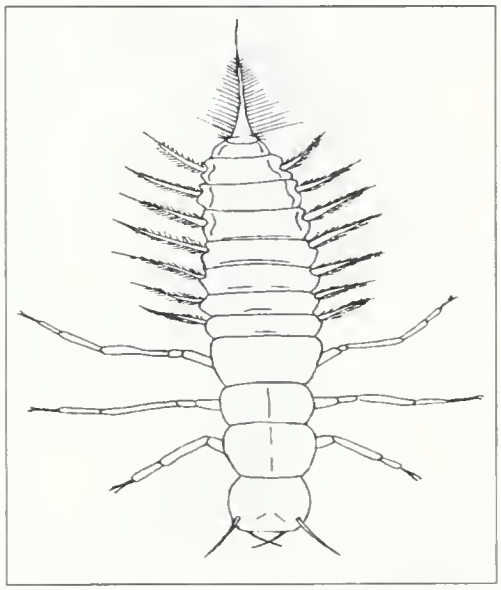
Plecoptera (stonefly)

- 6-50mm, yellowish, brown or blackish
- resemble mayflies but with 2 tails
- sometimes feather like gills under body
- flattened with legs out at sides, slow moving



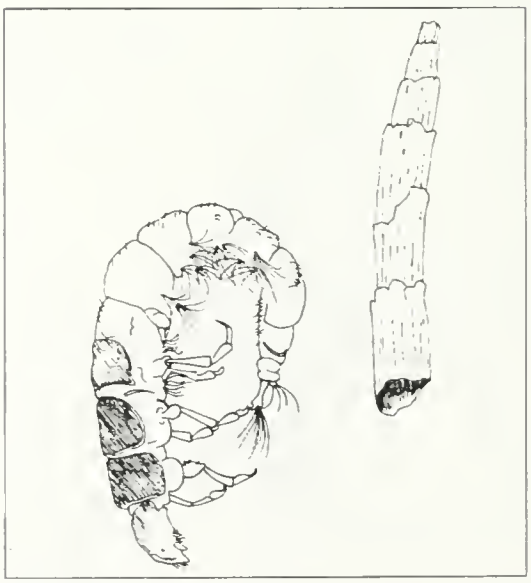
Hemiptera (true bugs)

-.15-40 mm, black or brownish
- legs often long, stick out from sides
- often two pair of folded wings (not hard).
- variable shapes, soft bodies



Megaloptera (alder flies)

- 25-90 mm long, brown
- large hairy crawlers resembling centipedes
- hairs are gills on first few abdominal segments
- carnivorous predators

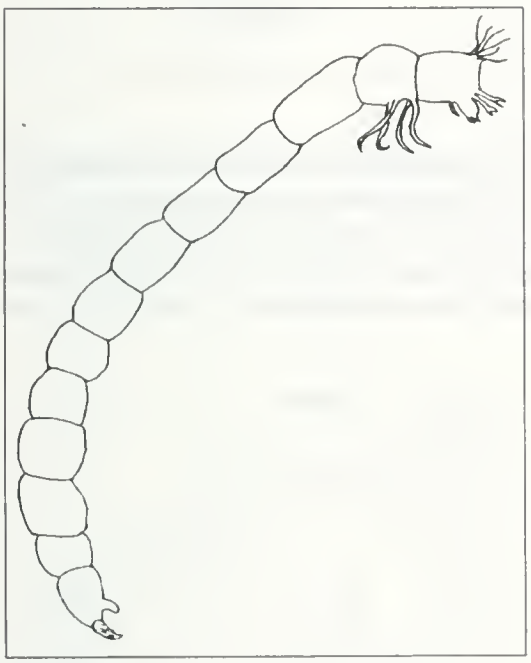


Trichoptera (caddisflies)

- 2 - 50 mm long, catterpillar shape
- head and thorax (3 segments) dark and hard
- body soft and cream coloured,
- 3 pairs of legs near front, slow movers
- often in 'house' of sticks, stones or sand

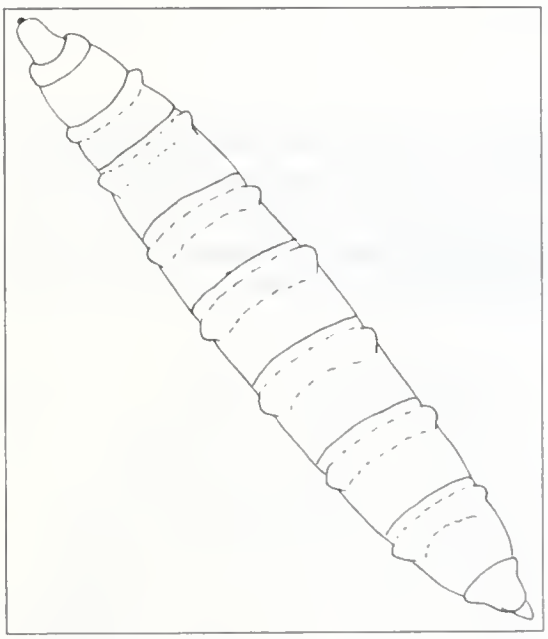
Diptera (flies, mosquitoes, midges)

- divided into 6 main groups that are illustrated on the NEXT TWO PAGES
- in general, distinguished by their short, worm like bodies with no eyes or jointed legs
- some diptera have "bumps" or prolegs on the abdomen
- adults have wings and disperse in the air
- larvae and pupae found in the sediments of lakes and streams
- variable in size, shape and colour



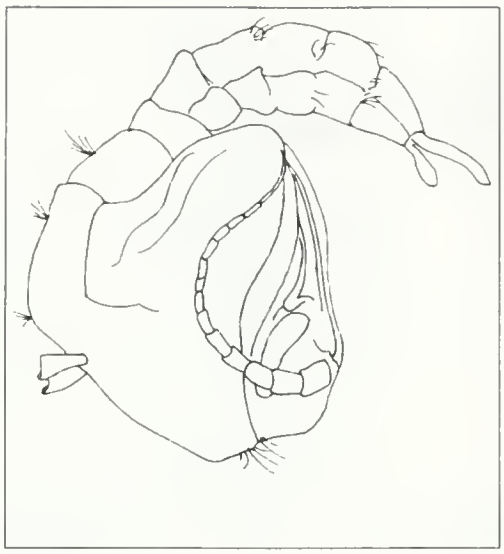
Chironomidae (midges)

- 2 to 30 mm, red, white or yellowish
- characteristic shape like letter "J"
- may be in a tube made of fine dirt particles
- creep along bottom of tray among plant material
- often caught in surface film



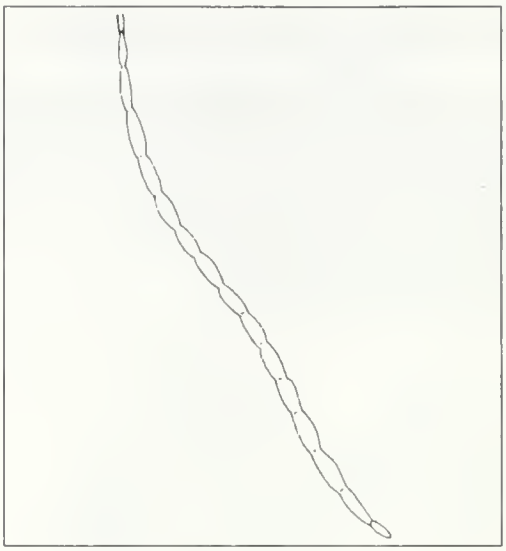
Tabanidae (horseflies)

- 15 to 40 mm, white or yellowish
- pointed at both ends, leathery texture
- segmented, straight or slightly curved
- seven pairs of small bumps along abdomen



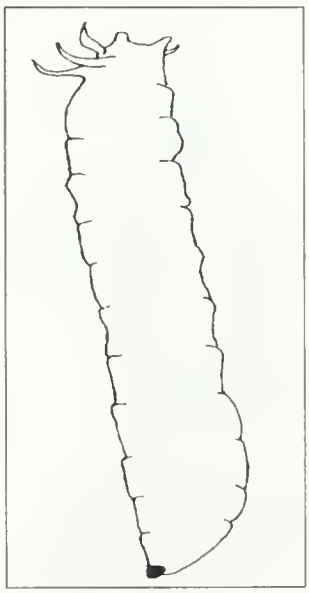
Culicidae (mosquitoe larva/pupa)

- 3-15 mm, brown, various shapes
- characteristic thickened body near head
- segmented body, curved at one end
- twitch in water when disturbed



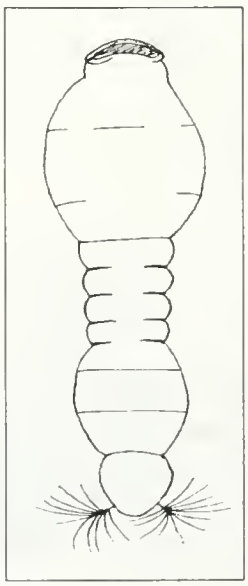
Ceratopogonidae (no-see-um)

- 3-13mm, whitish somewhat transparent
- very slender, pointed at both ends, segmented
- remain stiff when picked up with forceps
- move in a snake like fashion



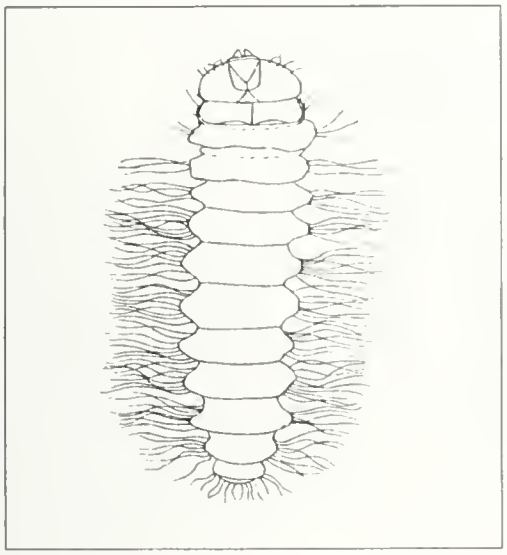
Tipulidae (crane fly)

- 10-50 mm, white, yellowish or brown
- leathery, semented, plump "maggot"
- pointed at both ends
- one end with finger like projections or lobes



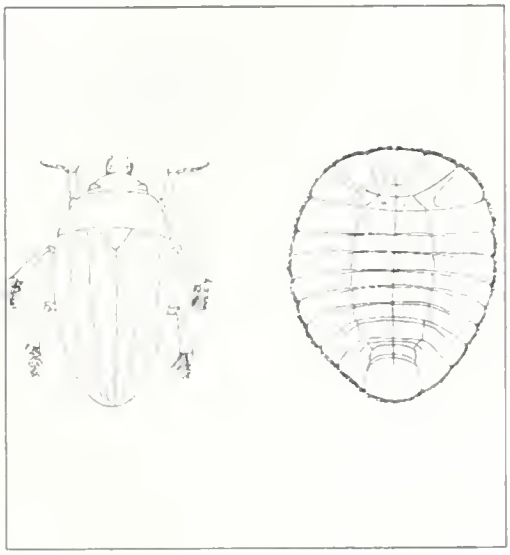
Simuliidae (black fly)

- 3 to 15 mm, brown or greyish clour
- like flattened maggot with one end 1/3 fatter
- move with loop (inch worm) movements
- often found in large numbers



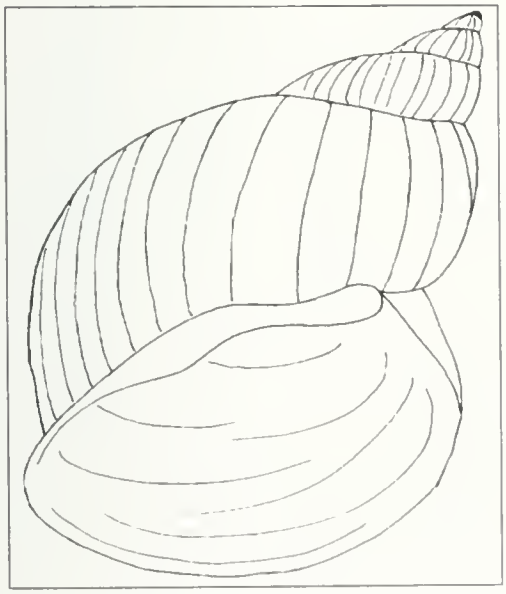
Lepidoptera (aquatic caterpillar)

- 10 - 25 mm, yellow, white or brown
- resembles caterpillar with short legs along body
- no dark segment near head like caddisflies
- crawl on vegetation or bottom of tray



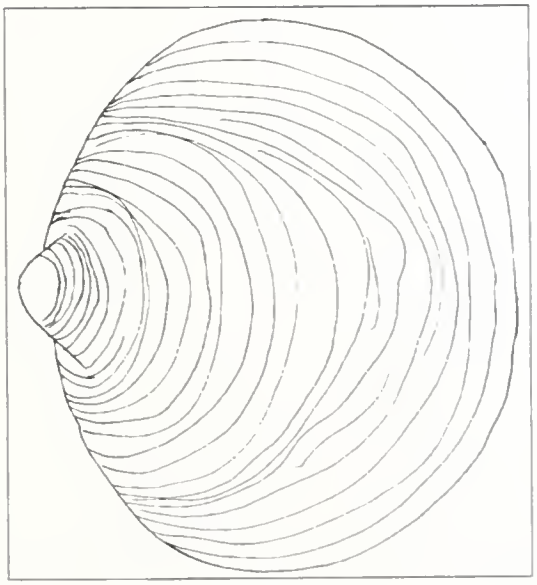
Coleoptera (riffle beetles)

- 2 - 20 mm, brownish (adults illustrated)
- most have 3 pairs of legs near the head
- larva may look like caddisflies but body is hard
- not more than 1 pair of small legs on abdomen



Gastropoda (snails)

- 2 - 70 mm, gray, brown or black
- hard shelled, spiral shape
- various sizes shapes and colours
- often floating in tray
- *do not count empty shells*



Pelecypoda (clams)

- 2 - 250 mm, white, yellow, brown, green, black
- hard oval shell hinged in two halves
- found in bottom of tray in sand or gravel
- *do not count empty (dead) shells*

APPENDIX 2

BENTHIC ENUMERATION SHEET

Lake or Stream Name: _____ Stream Code: _____ Site Code: _____ Date: ____ • ____ • ____ Crew: _____

Technique used: _____ Replicate number: _____ Number of Bottles: _____ Water Depth: _____ Slope (in): _____

Substrates present: Clay: ____ Silt: ____ Sand: ____ Gravel: ____ Cobble: ____ Boulder: ____ Bedrock: ____

COELENTERATA
(hydra)

TURBELLARIA
(flatworm)

NEMATODA
(unsegmented worm)

OLIGOCHAETA
(segmented worm)

HIRUDINEA
(leech)

ISOPODA
(sow bug)

AMPHIPODA
(scud)

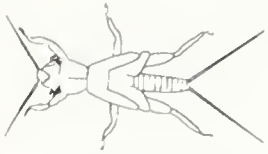
DECAPODA
(crayfish)

HYDRACARINA
(mite)

EPHEMEROPTERA
(mayfly)

ODONATA - ANISOPTERA
(dragonfly)

ODONATA - ZYGOPTERA
(damselfly)



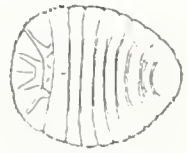
PLECOPTERA
(stonefly)

HEMIPTERA
(back swimmer)

MEGALOPTERA
(fishfly)

TRICHOPTERA
(caddisfly)

LEPIDOPTERA
(aquatic caterpillar)



COLEOPTERA
(riffle beetle)

Chironomidae
(midge larva)

Tabanidae
(horsefly)

Culicidae
(mosquito)

Ceratopogonidae
(no-see-um)

Tipulidae
(cranefly)

Simulidae
(blackfly)

DIPTERA

GASTROPODA
(snail)

PELECYPODA
(clam)

APPENDIX 3

EXAMPLE 1: COMPLETED STREAM SURVEY SHEET

Lake or (Stream) Name: SPRUCE CREEK Stream Code: SEC Site Code: 2 Date: 96 · 09 · 19 Crew: J SMITH B LAWRENCE

Technique used: KICK & SWEEP Replicate number: _____ Number of Bottles: _____ Water Depth: _____ Slope (in): _____

Substrates present: Clay: ___ Silt: 15 Sand: 25 Gravel: 40 Cobble: 20 Boulder: ___ Bedrock: ___

COELENTERATA (hydra)	TURBELLARIA (flatworm)	NEMATODA (unsegmented worm)	OLIGOCHAETA (segmented worm)	HIRUDINEA (leech)	ISOPODA (sow bug)
	𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	II		

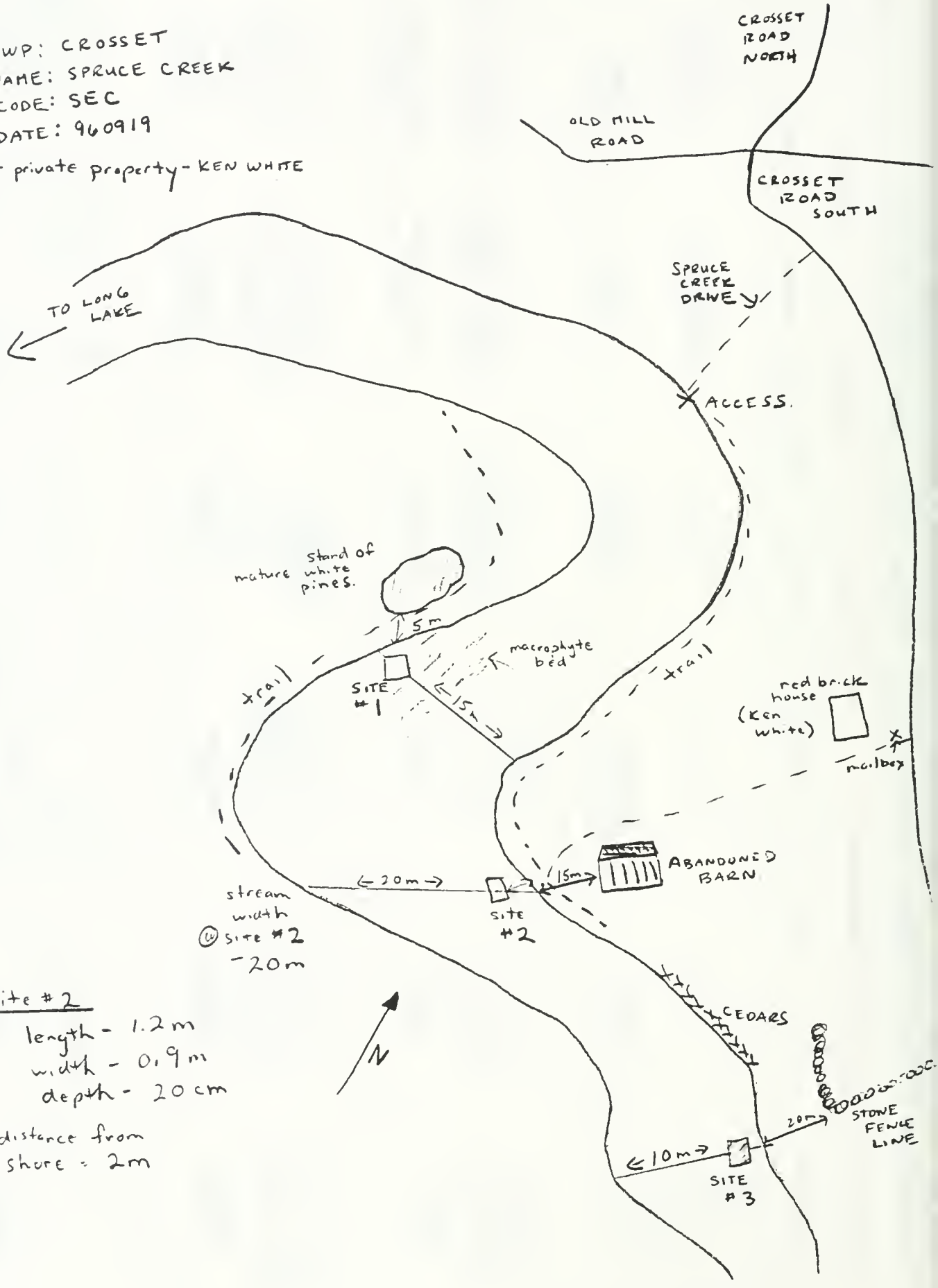
AMPHIPODA (scud)	DECAPODA (crayfish)	HYDRACARINA (mite)	EPHEMEROPTERA (mayfly)	ODONATA - ANISOPTERA (dragonfly)	ODONATA - ZYGOPTERA (damselfly)
			𝍸		

PLECOPTERA (stonefly)	HEMIPTERA (back swimmer)	MEGALOPTERA (fishfly)	TRICHOPTERA (caddisfly)	LEPIDOPTERA (aquatic caterpillar)	COLEOPTERA (riffle beetle)
IIII			III		

DIPTERA

Chironomidae (midge larva)	Tabanidae (horsefly)	Culicidae (mosquito)	Ceratopogonidae (no-see-um)	Tipulidae (cranefly)	Simulidae (blackfly)	GASTROPODA (snail)	PELECYPODA (clam)
𝍸 𝍸 𝍸 I		I	II	𝍸 𝍸 𝍸 I			I

TWP: CROSSET
NAME: SPRUCE CREEK
CODE: SEC
DATE: 960919
- private property - KEN WHITE



site #2

length - 1.2 m
width - 0.9 m
depth - 20 cm

distance from shore = 2m

APPENDIX 4

EXAMPLE 2: COMPLETED LAKE SURVEY SHEET

Lake or Stream Name: WOLF Stream Code: WFL Site Code: 1 Date: 96 · 09 · 20 Crew: J SMITH B LAWRENCE

Technique used: KICK & SWEEP Replicate number: _____ Number of Bottles: 1 Water Depth: _____ Slope (in): _____

Substrates present: Clay: ____ Silt: ____ Sand: 40 Gravel: 30 Cobble: 20 Boulder: 10 Bedrock: _____

submerged macrophytes ~ 40%

COELENTERATA (hydra)	TURBELLARIA (flatworm)	NEMATODA (unsegmented worm)	OLIGOCHAETA (segmented worm)	HIRUDINEA (leech)	ISOPODA (sow bug)
				1	

AMPHIPODA (scud)	DECAPODA (crayfish)	HYDRACARINA (mite)	EPHEMEROPTERA (mayfly)	ODONATA - ANISOPTERA (dragonfly)	ODONATA - ZYGOPTERA (damselfly)
𝍸 𝍸 𝍸 𝍸 𝍸 111			𝍸 𝍸 1	111	11

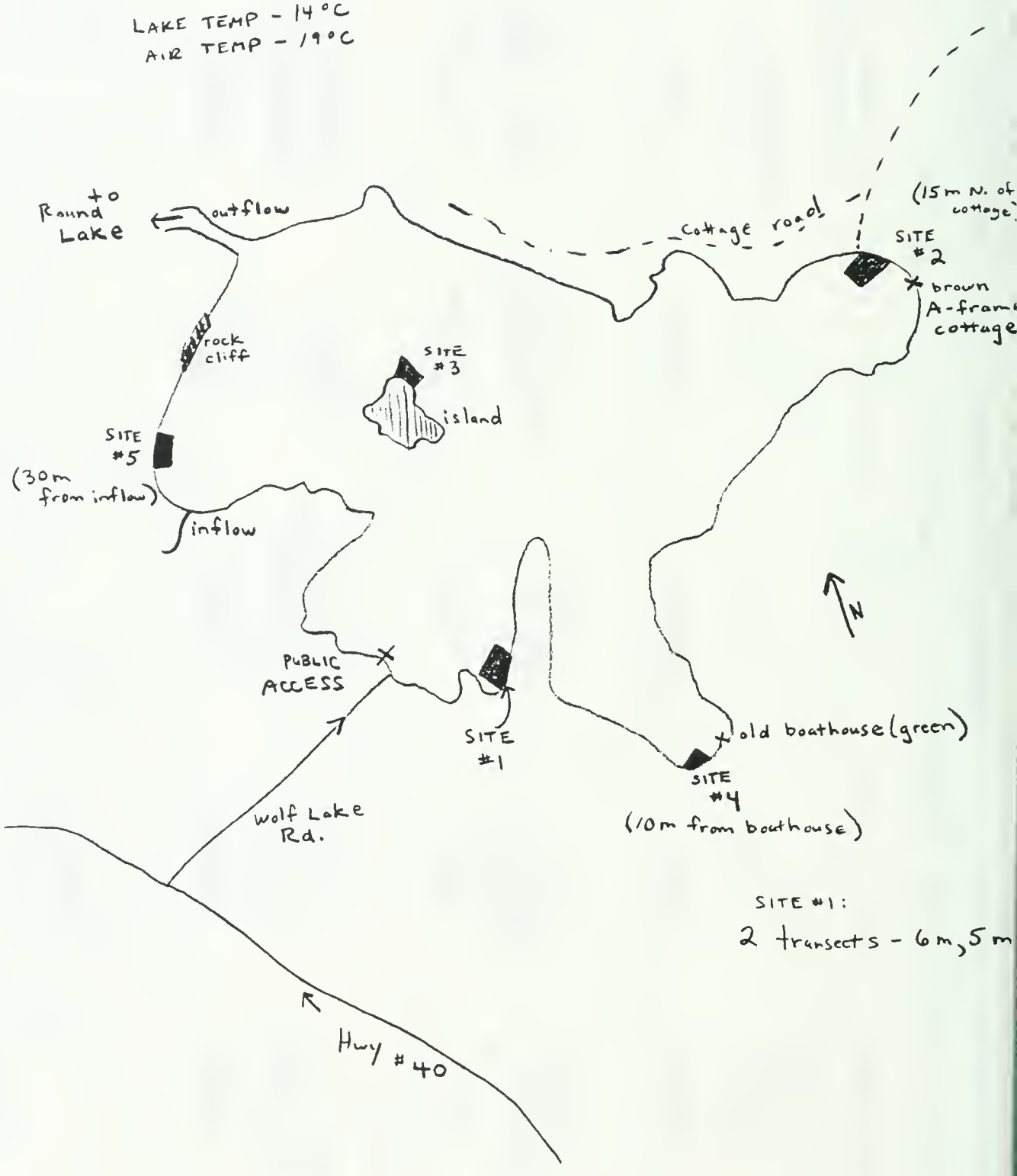
PLECOPTERA (stonefly)	HEMIPTERA (back swimmer)	MEGALOPTERA (fishfly)	TRICHOPTERA (caddisfly)	LEPIDOPTERA (aquatic caterpillar)	COLEOPTERA (riffle beetle)
			1		𝍸 𝍸 𝍸 𝍸 𝍸 1

DIPTERA

Chironomidae (midge larva)	Tabanidae (horsefly)	Culicidae (mosquito)	Ceratopogonidae (no-see-um)	Tipulidae (cranefly)	Simulidae (blackfly)	GASTROPODA (snail)	PELECYPODA (clam)
𝍸 𝍸 𝍸 𝍸 𝍸 11			𝍸				1

TWP: BURLEIGH
NAME: WOLF LAKE
CODE: WFL
DATE: 960920

LAKE TEMP - 14°C
AIR TEMP - 19°C



SITE #1:
2 transects - 6m, 5m